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TWENTY-SIXTH

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER COMPANY

ON

105 MM. BATTALION ANTI-TANK PROJECT

UNDER

Contract No. DA-33-019-ORD-33

ORDNANCE DEPARTMENT PROJECTS

TS4-4020—WEAPONS AND ACCESSORIES

TM1-1540—AMMUNITION

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THE FIRESTONE TIRE & RUBBER COMPANY

Defense Research Division

Akron, Ohio

SEPTEMBER 1952

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**TWENTY-SIXTH
PROGRESS REPORT
OF
THE FIRESTONE TIRE & RUBBER CO.
ON**

105 MM BATTALION ANTI-TANK PROJECT

**Contract No.
DA-33-019-ORD-33 (Negotiated)
RAD ORDTS 1-12383**

**THE FIRESTONE TIRE & RUBBER CO.
Defense Research Division
Akron, Ohio**

SEPTEMBER, 1952

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ABSTRACT

The location of and the component parts for each BAT weapon system manufactured by Firestone are presented. Illustrations of the T137E3 rifle, the T152E5 mount and the new fire control mechanism are shown. A charge development program was conducted to establish the pressure which would be developed in the T137E3 rifle with the regular M323 type charge. The test data are given and discussed. Data comparing piezo and copper pressure measurements are presented. The use of M32 cartridge cases in the T137E3 rifle is described. A future program is given.

Two accuracy tests of the T138E57 projectile at 2000-yard range are described and the firing data are presented. All firings with this projectile at this longer range are summarized. A future program is given.

Accuracy tests of the T119 projectile, at ranges of 1000 and 2000 yards are described. One of these programs was fired from a smooth bore tube and the other from a rifled tube. The results of charge development tests are discussed. An advance program is presented.

Penetration tests were conducted to investigate further the effect of internal tee configuration upon penetration. The test data are given. A future program for penetration studies is outlined.

Several aspects of projectile fuzing were investigated. These involved the superquick-delay mechanical fuze, the nose element crystal assemblies and the DRD328 base element. The tests are discussed. A future program is presented.

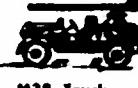
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THE WEAPON SYSTEM

A distribution report is given in Table I showing the locations and the component

parts of the BAT weapon systems manufactured by Firestone.

Table I
Weapon System Distribution
BAT Weapon Systems Manufactured by Firestone
Locations and Component Parts

Fort Benning, Georgia	Aberdeen Proving Ground	Erie Ordnance Depot
  M38 Truck	 T137E4 Mount	 M38 Truck
<u>One Unit</u> <ul style="list-style-type: none"> Rifle - T137E1 Mount - T152E2 Spotting Rifle - Returned to Springfield Armory Direct Sight - Returned to Frankford Arsenal Direct Sight Mount - T183 Truck - M38 	<u>One Unit</u> <ul style="list-style-type: none"> Rifle - T137E1 Mount - T152E2 Spotting Rifle - Returned to Springfield Armory Direct Sight - Returned to Frankford Arsenal Direct Sight Mount - T183 Truck - Taken for use with other unit 	<u>One Unit</u> <ul style="list-style-type: none"> Rifle - T137E1 Mount - T152E2 Spotting Rifle - Returned to Springfield Armory Direct Sight - Returned to Frankford Arsenal Direct Sight Mount - T183 Truck - M38
	<u>One Unit</u> <ul style="list-style-type: none"> Rifle - T137E2 Mount - T152E4 Spotting Rifle - Returned to Springfield Armory Direct Sight - Returned to Frankford Arsenal Direct Sight Mount - T183 Indirect Sight - M3A1E1 	<u>One Unit</u> <ul style="list-style-type: none"> Rifle - T137E2 Mount - T152E4
	<u>Two Units</u> <ul style="list-style-type: none"> Rifles T137E3; replace T137E2 rifles Mounts - One T152E4; One T152E5 Spotting Rifles - T46 Direct Sights - M62E4 Direct Sight Mounts - T183 Indirect Sights - M3A1E1 Trucks - M38 	
	Miscellaneous Components <ul style="list-style-type: none"> 1 Rifle - T137E2 	
<p>T137E1 - 85 in. tube, Firestone breech mechanism. T137E2 - 95 in. tube, modified M27 breech mechanism T137E3 - 105 in. tube, M27 breech mechanism; modified to fire T170 ammunition & T119 and T138 T152E2 - Elevating mechanism forward of trunnions, taper leg locks, center fire control buttons T152E3 - Similar to E2 except for use of roller bearings and guide rails on elevating system T152E4 - Ratchet-type leg locks, safety lock on firing mech.; squeeze type triggers, free traverse lever T152E5 - Identical to E4 except new tripod designed to attach to body flange M38 or M38A1</p>		

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The T137E3 rifle, shown in Fig. 1, was designed to chamber M323 and M325 ammunition as well as T119 and T138 ammunition. Table I shows that a T137E3 rifle is a component of two systems now at Aberdeen Proving Ground, one with a T152E4 mount and one with a T152E5 mount.

The T152E5 mount, shown in Fig. 2, includes all of the revisions of the T152 E4 mount plus a new tripod designed to attach to the top body flange of either the M38 or M38A1 truck. The salient features of the T152E5 mount are shown

in Fig. 2. The T152E4 mount at Aberdeen Proving Ground will be made into a T152E5 assembly by replacing the legs and lower housing with corresponding T152E5 parts.

A special feature of the T152E4 and T152E5 mounts is the squeeze type trigger located on the handwheel knobs. Fig. 3 shows this trigger and also the safety lock on the firing mechanism.

Fig. 4 is an assembly of the T137E3 rifle and T152E5 mount.

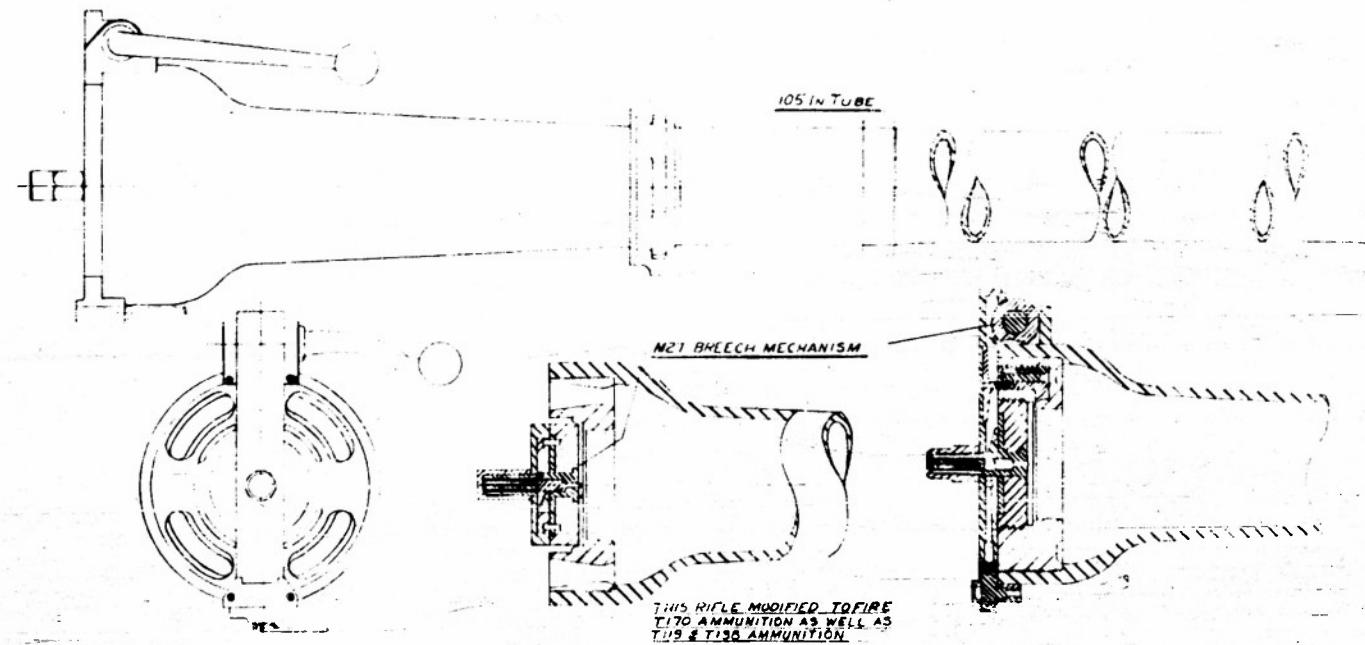


Fig. 1. T137E3 Recoilless Rifle.

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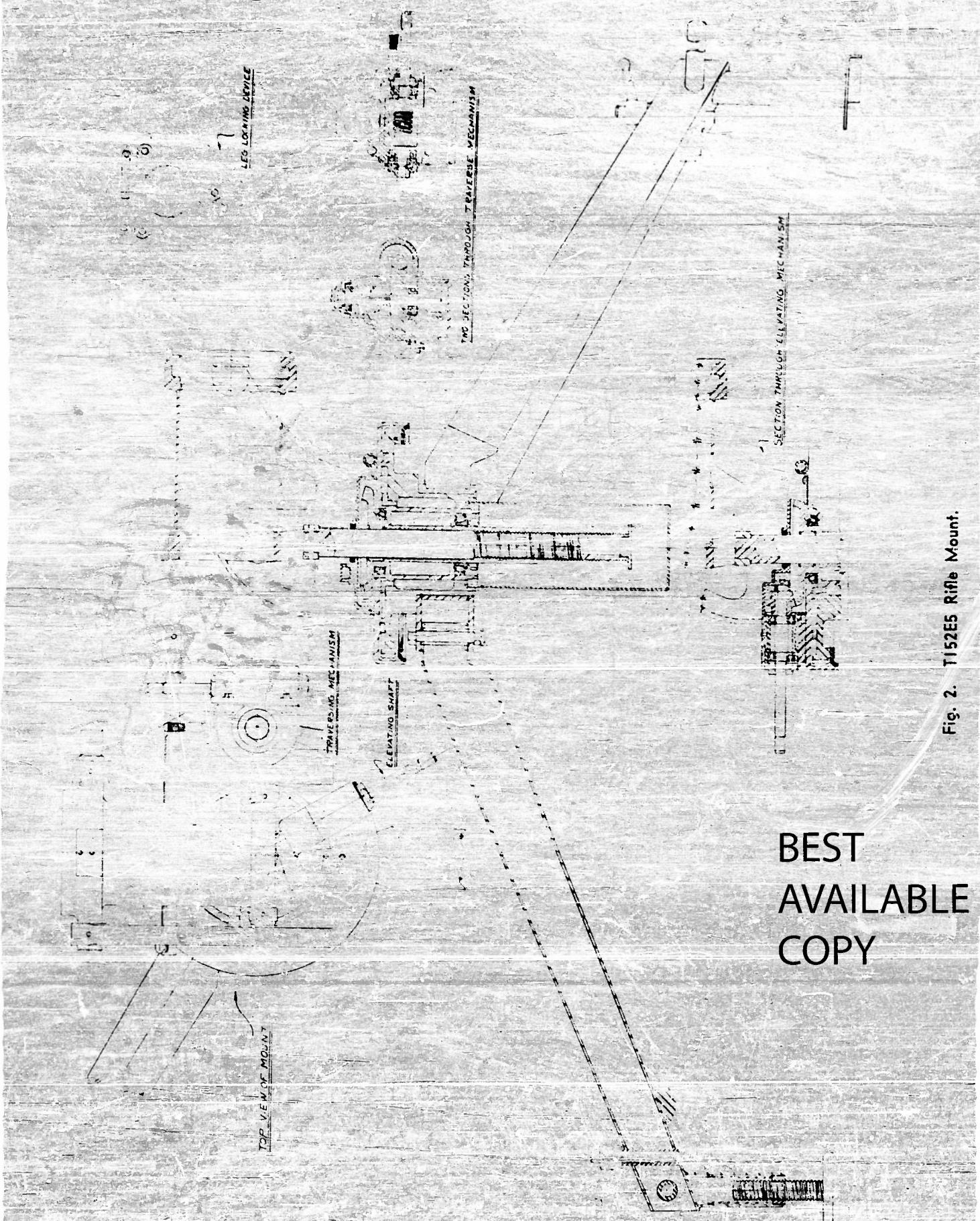


Fig. 2. T152E5 Rifle Mount.

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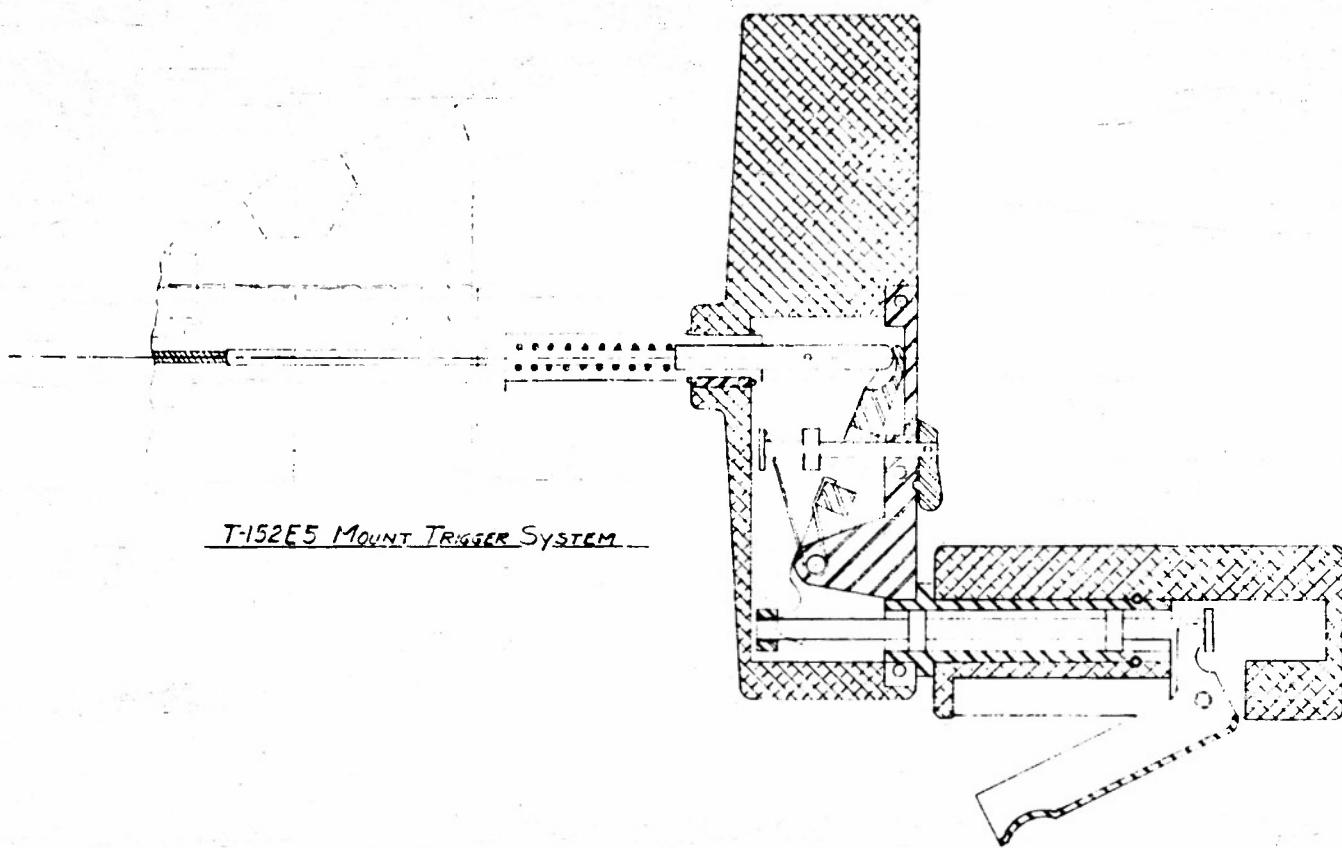


Fig. 3. Squeeze Type Trigger and Safety Lock.

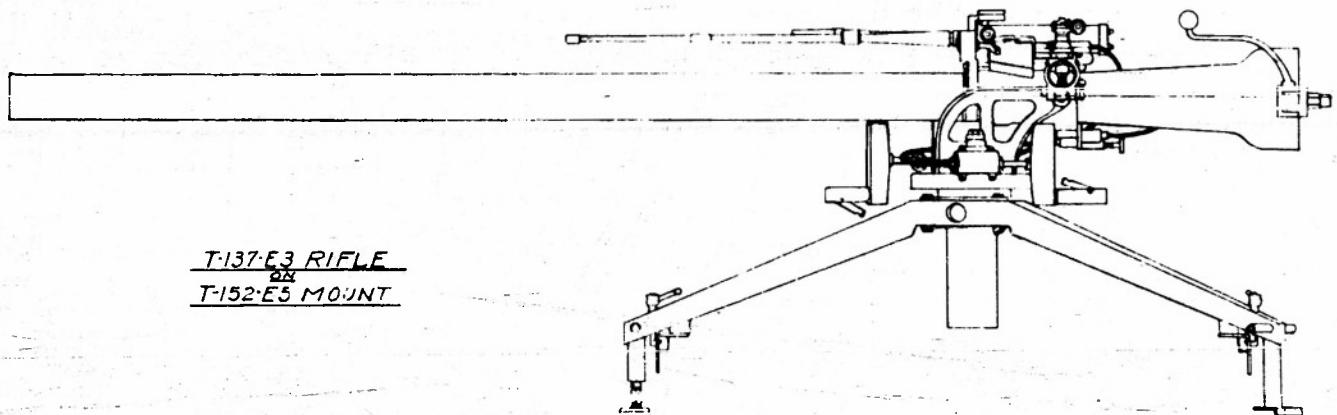


Fig. 4. Assembly of T137E3 Rifle and T152E5 Mount.

CONFIDENTIAL**Charge Development for 34-pound Projectile**

Since the T137E3 rifle was designed to chamber M323 and M325 ammunition as well as T138 and T119 ammunition it would be convenient if rounds loaded for the M27 rifle could be safely fired from the T137E3 rifle. A charge development program was conducted at Erie Ordnance Depot to see if this is possible. PA-30240 propellant and 34-pound M2A1 howitzer slugs were used to establish the pressure which would be developed in the T137E3 rifle with the regular M323 type charge. The data for this charge development are given in Table II and Fig. 5.

The pressure required for a muzzle velocity of 1120 ft/sec is 12,300 lb/sq in (cu). This exceeds the maximum rated pressure of the rifle (11,000 lb/sq in). The M323 round for the M27 rifle contains approximately 8 lb of M10, .035-in web powder. An extrapolation of the data in Fig. 5 shows that a pressure of 13,700 lb/sq in would result for an 8-lb charge of PA-30240 propellant. Although the web of PA-30240 propellant is smaller (.033 in) than that used with the M323 round (for the M27 rifle) it appears clear that it would not be safe to fire a regular M27 round in the T137E3 rifle. It is proposed to load the M323 and M325 rounds for the T137E3 rifle with PA-E-6119 (.038-in web) or with the duplex loading being developed by Frankford Arsenal.

Table II
Charge Development Data
34-pound Slug

Round No.	Charge (lb-oz)	Velocity (ft/sec)	Pressure (lb/sq in Cu)
1	7-2	1040	10,250
2	7-4	1067	10,650
3	7-6	1089	11,450
4	7-8	1108	12,400
5	7-6	1080	11,400
6	7-8	1096	11,700
7	7-10	1108	12,000
8	7-12	1137	12,800
9	7-11	1136	12,550

Notes:

Rifle, T137E2, 105" tube.

Powder: PA-30240, M10, MP.

Rotating Band: DRB360-3.

C O N F I D E N T I A L

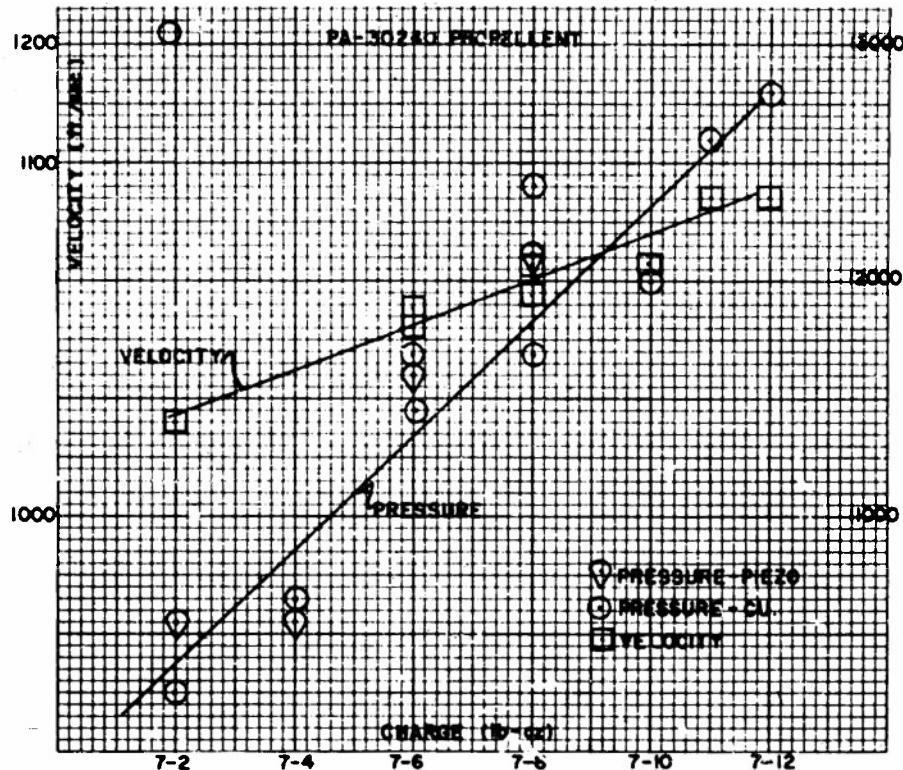


Fig. 5. Charge Development Data.

34-pound Projectile.

Piezo-Copper Pressure Measurement

It is well known that the relation between copper pressure and piezo pressure depends on the particular rifle and propellant used. Table III and Fig. 6 show data obtained with the T137E2 rifle using PA-30240 propellant. Over the range

10,000 lb/sq in to 13,000 lb/sq in, it is seen that the comparison between M3 copper gauges and external piezo gauges is essentially one to one. Since both 17.5-lb slugs and 34-lb slugs were used it appears that over this range the projectile weight does not affect the copper-piezo relationship.

Table III
Copper-Piezo Pressure Relations

Projectile Weight(lb)	Piezo Pressure (lb/sq in)	Copper Pressure (lb/sq in)
17.5	7,382	7,350
17.5	10,810	10,400
17.5	11,601	12,250
17.5	12,128	13,350
17.5	12,919	12,850
17.5	12,655	13,100
34	10,550	10,250
34	10,550	10,650
34	11,600	11,450
34	12,133	12,400
34	10,734	11,150

Note: Copper pressures are averages of two M-3 gages.

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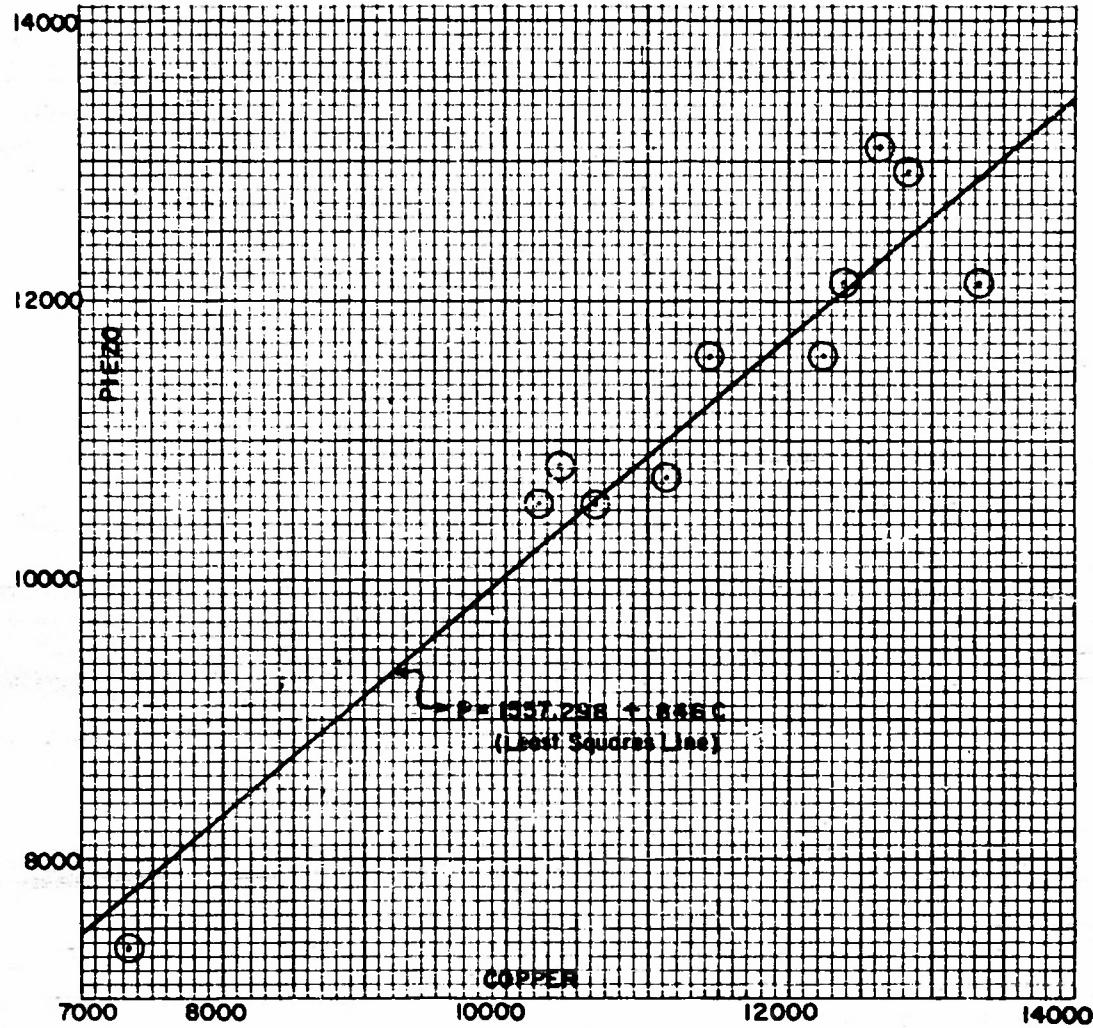


Fig. 6. Copper-Piezo Relationship.

Cartridge Case

It was stated in the Twenty-fifth Progress Report that the M32 cartridge case, with minor modifications, was used in the T137E3 rifle. It was found necessary to heat treat the M32 case to prevent bulging. Several tests were performed with the objective of making the heat treatment unnecessary. The data for these tests are given in Table IV. Modifications A, B, C, D were attempts to obtain more rapid ignition at the base of the shell case. Modification B gives a slight improvement in case bulging but does not

permit a 115% pressure round to be fired without bulging the case. Other modifications did not give significant improvement. Therefore the heat treatment of the M32 shell case is still necessary.

Although the use of the T-88 primer, which has only 300 grains of A-1 black powder, does not reduce case bulging, ignition at 70°F seems as satisfactory as with the 1000 grain M57 primer. Low temperature tests will be conducted with this primer to see whether it is satisfactory at -40°F.

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Table IV
M32 Cartridge Case Tests
Bulging Tests

Case Type	Charge (lb oz)	Pressure (lb/sqin)	Ignition	Remarks
Not heat treated	7-5	8,300	M57 Primer	no bulge
" "	7-10	10,450	" "	" "
" "	7-13	10,550	" "	" "
" "	7-11 1/2	10,150	" "	slight bulge
" "	7-11 1/2	10,650	" "	" "
" "	7-11 1/2	9,950	" "	" "
" "	7-11 1/2	10,450	" "	bad bulge
" "	8-8*	10,750	" "	" "
" "	8-6*	9,850	" "	no bulge
Heat treated	8-4	12,700	" "	" "
" "	8-4	12,500	" "	" "
" "	8-6	13,500	" "	" "
" "	8-6	13,500	" "	" "
Not heat treated	7-11 1/2	10,300	M57 Mod. A	slight bulge
" "	7-11 1/2	10,400	M57 Mod. A	" "
" "	7-11 1/2	--	M57 Mod. B	no bulge
Not heat treated	8-6	--	M57 Mod. B	bad bulge
" "	7-13 1/2	11,400	M57 Mod. C	slight bulge
" "	7-13 1/2	11,700	M57 Mod. D	" "
" "	7-13 1/2	10,900	T88	no bulge
" "	8-9	13,800	T88	slight bulge

Modifications:

- A. 3 1/2" sleeve on tip of primer.
- B. Twelve holes at tip of primer covered, no pressure gages, base of polyethylene liner removed.
- C. Twelve additional holes at base of primer.
- D. Doughnut of 100 grains A-1 black powder 3" from base of primer.

* PA-E-6084 propellant. All other rounds used PA-30239.

Future Program

1. Two rifle systems will be shipped to Fort Benning, Georgia for Field Forces evaluation. A third weapon system will be shipped to Aberdeen Proving Ground for engineering tests.
2. Continue design study of a light weight, wheeled mount.
3. Establish an experimental pressure-travel curve.
4. Evaluate four lots of special double base propellents for temperature coefficient.
5. Evaluate the T-88 primer for low temperature ignition.

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T138 PROJECTILE

**Performance of T138E57 Projectiles
at 2000 Yards**

Two programs in which T138E57 projectiles were fired at a 2000-yard range at Erie Ordnance Depot were reported in the Twenty-Third Progress Report.

A third program to test the accuracy of the T138E57 projectile at a 2000-yard range was fired at Aberdeen Proving

Ground. Twenty rounds were fired at a 20 ft by 20 ft target. Four rounds were spent in getting on the target and ten of the next sixteen rounds hit the target. The probable errors for the hits were V.P.E. = .74 mil and H.P.E. = .65 mil. Observers reported good flight for four rounds that missed the target and slight precession in four other rounds. The firing record for this test is found in Table V and Fig. 7 is a plot of the target.

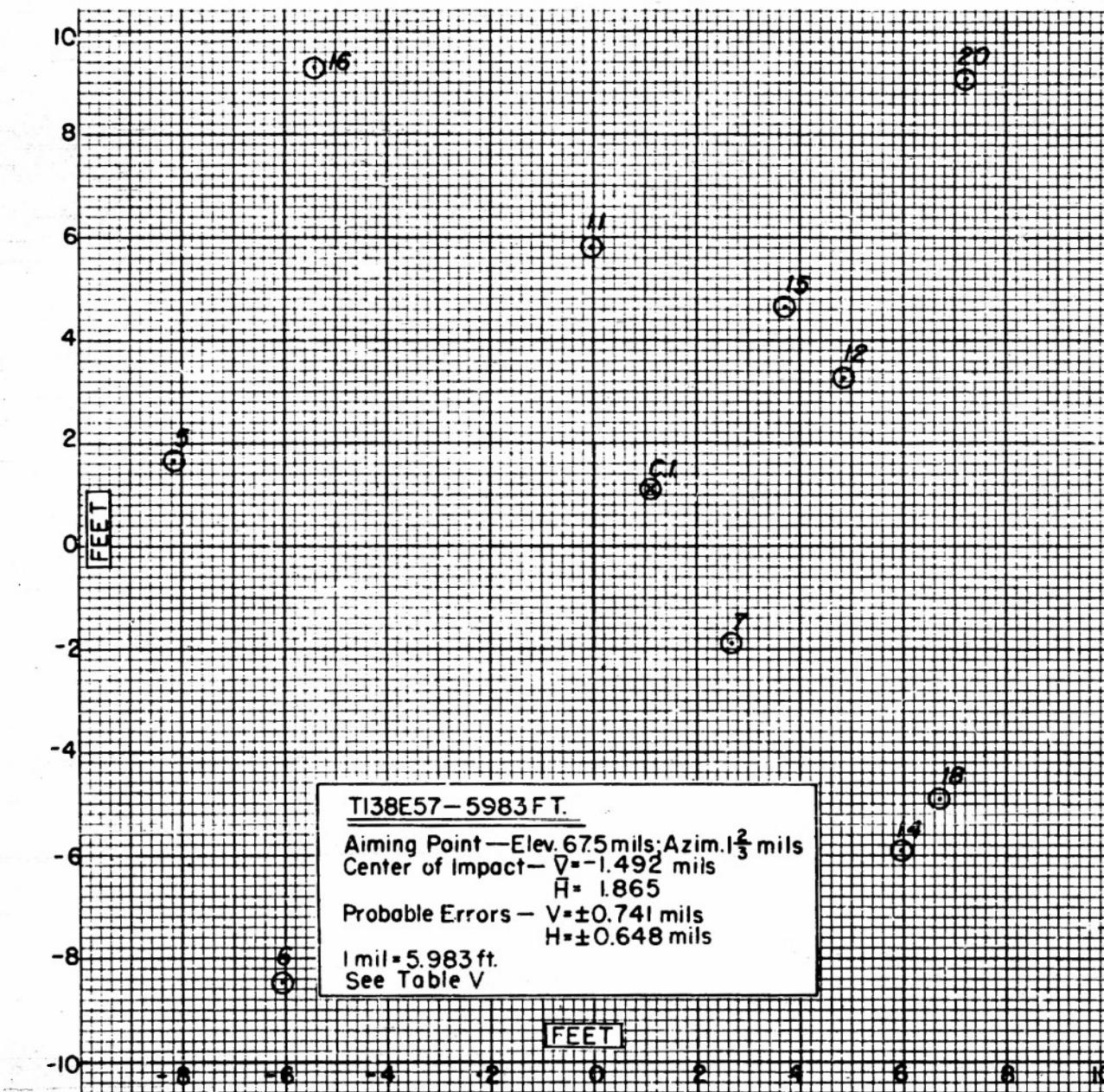


Fig. 7. Dispersion Chart.
T138E57 Projectile, 2000 Yards, 1-200 Tube.

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Because of the good performance of the T138E57 at ranges of less than 2000 yards it was thought desirable to determine whether the accuracy of the T138E57 at longer ranges (above 1500 yards) could be improved by launching at a higher spin rate. Therefore, a fourth accuracy program at 2000 yards was undertaken.

Nineteen rounds of T138E57 projectiles were fired at Erie Ordnance Depot from a modified T19 rifle with a 1-120 tube. One round hit a velocity coil and fourteen of the remaining eighteen rounds hit the target. The probable errors for the hits are V.P.E.=.54 mil and H.P.E.=.46 mil.

The target size was 20 ft by 20 ft. None of the misses were observed to have poor flight characteristics. Table VI is a copy of the firing record and Fig. 8 is a plot of the hits on the target.

When fired at 45 rev/sec (1-120 tube) twelve of the fourteen hits had no measurable yaw; at 25 rev/sec (1-200 tube) only two of ten had angles of yaw of less than 8 degrees and two had yaw angles of 25 degrees.

Table VII summarizes the data for the performance of the T138E57 projectiles at 2000 yard range.

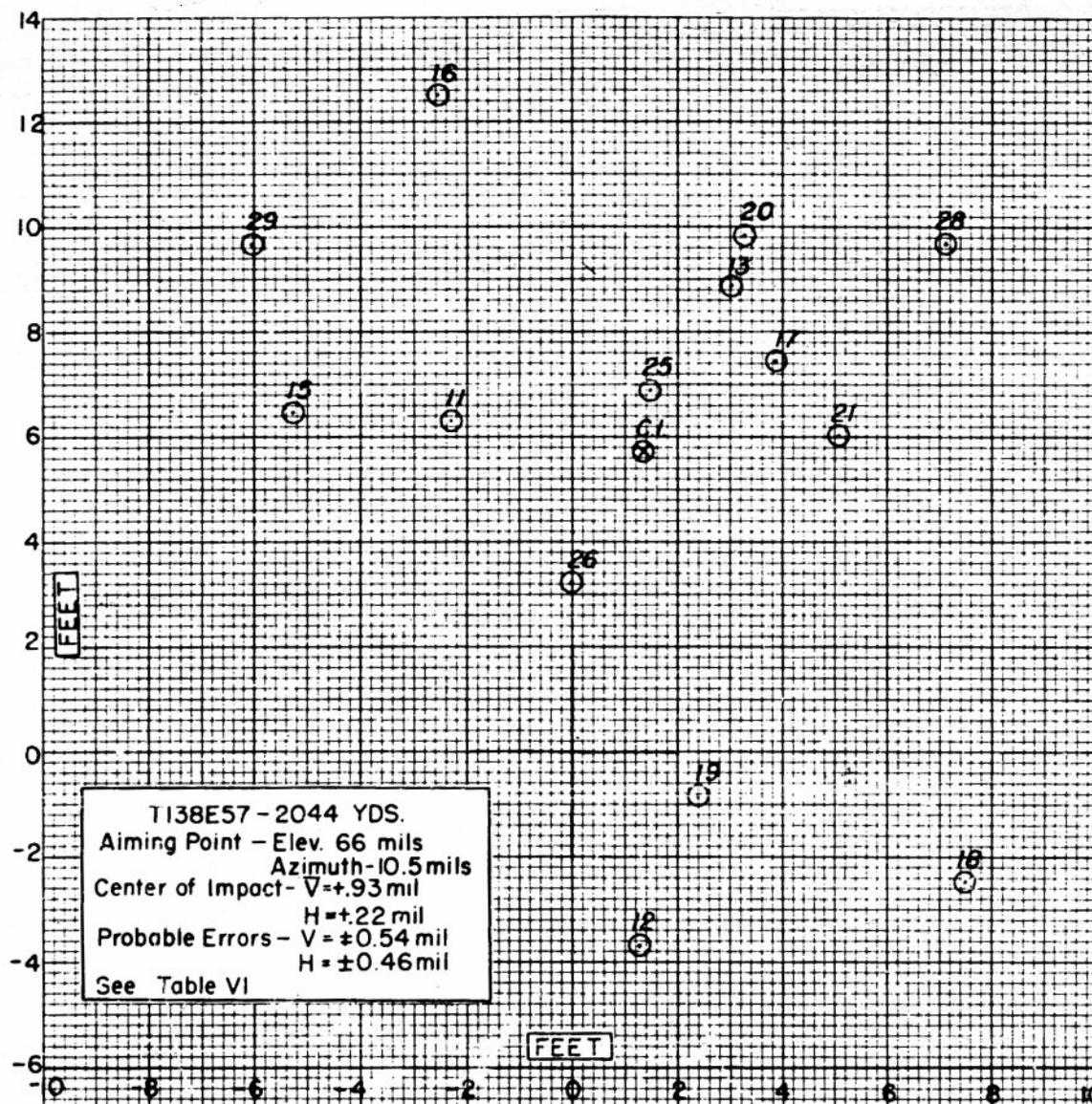


Fig. 8. Dispersion Chart
T138E57 Projectile, 2000 Yards, 1-120 Tube.

C O N F I D E N T I A L

Table V
Firing Data
2000-yard Range, T138E57 Projectile, 1-200 Tube
Aberdeen Proving Ground

Date 2-12-52

Program

COMPONENTS

T-32 SHELL CASE
 T-21 PRIMER
 170 GRAIN PROJECTILE
 170 GRAIN DISKS (Unicellite)
 170 GRAIN OF PARACORD
 POLYETHYLENE & RAYON
 WORKERS.

WEIGHT (Nominal)

—

C.G. Location

—

Bourellet Dia (Inch)

—

Special Features

Rotating Band

.00-.5

TEST GUN

Model T-222

Type

E-57A

Length of Tube

95 in.

Length of Rifling

L-2.00

Sighting Equipment

T132 MONO & Gunner's Quadrant

Bore Dia. (Inches)

.4134 ± .001

SCREEN DISTANCES

300 ft. — 500 ft.

MISCELLANEOUS DATA

Range 2223 ft.

Proportion

Type

T132

C O N F I D E N T I A L

Table VI
Firing Data
2000-yard Range, T138E57 Projectile, 1-120 Tube
Erie Ordnance Depot

TEST GUN										MISCELLANEOUS DATA			
<u>Model T138 No. 6</u>										Range 2044 yds			
Type E57										Type <u>2042 web base</u> , Change Wt. 216 lbs.			
Weight (Nominal) <u>17.20 lb</u>										Length of Tube <u>86 in.</u>			
C.G. Location <u>.585 in. from base</u>										Twist of Riffing <u>L-120</u>			
LOADING ROOM - 70°										Sighting Equipment <u>2017 Mod. Elbow Telescope</u>			
AMBIENT - 70°										Twist of Riffing <u>L-120</u>			
LOADING ROOM - 70°										Twist of Riffing <u>L-120</u>			
COMPONENTS										Proof Director <u>Ed HUEMAN</u>			
Polyethylene Liner - Bare Dia (Lands) <u>.4184 + .001</u>										Observer <u>LUCAS, CLARK, LOVIE, BRENNAN</u>			
3 Block Upline Guide Bars										36 Small Hole Shell Case			
M37 Primer										Corrected to 66 mil			
PROJECTILE										SCREEN DISTANCE			
Model <u>T138</u>										69' 6" + .50'			
Weight <u>17.20 lb</u>										Recordation Factor <u>.245</u>			
Round No.	Proj. No.	Proj. Weight	Powder Charge	Wind	Muzzle Velocity	Zero	Instr. Actual	Elev.	Azimuth	Position of Hit (in)	Corrected Position	Clearance	
		(lb.)	(lb.)	Dir.	(ft/sec.)	(in.)	(ft/sec.)	(mils)	(mils)	(in.)	of Hit - mils	Front	Rear
3044 - 11	3046 - 11	17.39	.8 - .8	10 - 95	3.5	1793	1792	66.0	-10.5	+75.5	-27.5	+1.03	-3.3
3045 - 12	3047 - 12	17.38	.8 - .8	7 - 100	"	1725	1748	66.0	-10.5	+4.4	+14.5	-6.0	+.20
3046 - 13	3048 - 13	17.34	.8 - .8	7 - 105	3.6	1793	1790	66.0	-10.6	+10.6	+36	+1.44	0
3047 - 14	3049 - 14	17.34	.8 - .8	13 - 165	"	1747	1750	66.0	-10.6	+133.80	"	"	"
3048 - 15	3050 - 15	17.31	.8 - .8	16 - 160	"	1748	1771	65.0	-10.5	+4	-62.5	+1.05	-.86
3049 - 16	3051 - 16	17.42	.8 - .8	10 - 125	"	1744	1767	65.0	-13.5	+76	-81	+2.04	0
3050 - 17	3052 - 17	17.38	.8 - .8	12 - 126	4.0	1726	1768	65.0	-10.5	+15.5	+46	+1.21	+6.3
3051 - 18	3045 - 18	17.38	.8 - .8	15 - 120	"	1735	1752	65.0	-10.5	-10.5	+89	-1.41	+1.22
3052 - 19	3054 - 19	17.35	.8 - .8	11 - 130	"	1795	1766	65.0	-10.6	-88.5	+28.5	-.14	+.59
3053 - 20	3063 - 20	17.29	.8 - .8	12 - 125	"	1735	1762	65.0	-10.5	+4.6	+98.6	+1.60	+.53
3054 - 21	3041 - 21	17.35	.8 - .8	14 - 100	"	1736	1767	65.0	-10.5	-5	+57.5	+1.99	+.82
3055 - 22	3021 - 22	17.35	.8 - .8	2.0 - 120	"	1735	1748	65.0	-10.5	+133.80	"	"	"
3056 - 23	3055 - 23	17.51	.8 - .8	18 - 110	"	1725	1749	65.0	-10.5	+133.80	"	"	"
3057 - 24	3002 - 24	17.29	.8 - .8	13 - 195	4.2	1750	1773	65.0	-10.5	HIT	Col.	"	"
3058 - 25	3001 - 25	17.98	.8 - .8	-	"	SCREEN	SCREEN	66.0	-10.5	+81.5	+16.5	+1.12	+2.9
3059 - 26	3086 - 26	1740	.8 - .8	-	"	SHOT OUT	SHOT OUT	66.0	-10.5	+39.0	0	+.53	.00
3060 - 27	3084 - 27	1738	.8 - .8	-	"	N.D.	66.0	-10.5	+133.80	-	-	-	-
3061 - 28	3041 - 28	11.54	.8 - .8	-	"	VELOCITIES	VELOCITIES	66.0	-10.5	+85.6	+115	+1.17	.5°
3062 - 29	3092 - 29	11.96	.8 - .8	-	"			66.0	-10.5	-71.5	+115	+1.57	-.98
Electric Firing System Used													
Center of Impact <u>H = t22 mil; V = +.95 mil</u>													
Probable Error - Vertical <u>.54 mil</u>													
Probable Error - Horizontal <u>.46 mil</u>													
For 14 HITS													
Signed - Z. SWEEZY													

C O N F I D E N T I A L

C O N F I D E N T I A L

Table VII
Summary of 2000-yard Firings
T138E57 Projectile

Date Fired	No. Rds. Fired	No. Hits	Size of Target(ft.)	Twist of Tube	Length of Tube(in.)	P.E. of Hits(mils)		Weight of Proj.(lb)	Rifle	Where Fired
						V.P.E.	H.P.E.			
6-5-52	22	13	18 x 18	1-200	95	.69	.63	17.5	T137E1	E.O.D.
6-20-52	22	17	24 x 24	1-200	95	.76	.83	17.5	T137E1	E.O.D.
9-12-52	16	10	20 x 20	1-200	95	.74	.65	17.5	T137E2	A.P.G.
9-25-52	18	14	20 x 20	1-120	85	.54	.46	17.5	T19#6	E.O.D.

Future Program

1. A group of inert rounds are being prepared for a comparison accuracy firing program to be fired at Aberdeen Proving Ground. Projectiles will be fired for accuracy at ranges of 1500 and 2000 yards using tubes having 1-200 and 1-120 twists under as nearly identical conditions as

possible.

2. A group of HEAT rounds using special liners will be fired for penetration at Aberdeen Proving Ground from a tube having a 1-120 twist.

CONFIDENTIAL**T119 PROJECTILE****Accuracy Programs - T119 Projectile**

During the past month, T119E8 projectiles were fired for accuracy at ranges of 1000 and 2000 yards.

Accuracy at 2000 Yards

The 2000-yard program, fired at Aberdeen Proving Ground, was intended to provide a check on accuracy data previously obtained at Erie Ordnance Depot. A total of 25 rounds of T119E8 projectiles, including 6 rounds for gun conditioning and "laying on" the target, were fired. Nineteen hits were obtained on the 20 ft. by 20 ft. target. The probable errors of dispersion were V.P.E.=.50 mil and H.P.E.=.34 mil. A T137E2 gun with a 105-in., smooth bore tube was used for this program. Table VIII is a chart showing the details of the T119E8 projectile and Table IX is a copy of the range data.

The results of this test are in agreement with earlier tests at 2000 yards and confirm that the T119 projectile has good accuracy for at least 2000 yards.

Accuracy From a Rifled Tube

To determine the accuracy of the T119 E8 projectile when launched without obturation from a tube rifled 1-20, twenty T119E8 projectiles were fired at Erie Ordnance Depot at a range of 1000 yards. A modified T19 rifle was used because an appropriately rifled tube was not immediately available for the T137 rifle.

The rounds were fired in two groups. One group of twelve T119E8 rounds was fired in the morning. Eleven rounds hit the target; the twelfth struck a velocity screen and missed the target. An additional group of eight T119E8 rounds was fired in the afternoon. The second

round fired went over the target, and the aiming point for the remaining rounds was changed. Separate centers of impact were calculated for each group of hits, and the two centers of impact were superimposed for the calculation of the dispersion. The probable errors of the dispersion for the eighteen hits were V.P.E.=.44 mil and H.P.E.=.47 mil. The firing data are contained in Table X.

The shift in the center of impact is attributed to a tightening of the gun tube in the chamber when the gun conditioning slugs were fired. It was noted that the torque from rotation of the banded slugs caused the tube to turn approximately one inch on its circumference relative to the chamber. Total gun elevations were established with a gunner's quadrant positioned on a flat on the chamber. In a later program with another projectile, it was established that the T19 rifle had a large forward recoil and it is felt that this may have contributed to the dispersion.

These results demonstrate that the T119 projectile can be fired, without obturation, from a tube rifled 1-20. The accuracy is within the .5 mil requirement for the BAT weapon.

Charge Development

A charge development program was fired at Aberdeen Proving Ground. A charge of 8 lb. 4 oz. of M10MP propellant, .038-in. web, lot number PA-E-6119, was found to produce a velocity of 1700 ft/sec when the T119E8 projectile, assembled with the T53E1 shell case and M57 primer, was fired from the T137E3 rifle. On the basis of this charge development, Picatinny Arsenal has been instructed to load T119E8 rounds with 8 lb. 4 oz. of PA-E-6119 propellant.

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T119E8 Projectile for Engineering and Service Board Tests

<u>Type</u>	<u>Date Shipped To Picatinny</u>	<u>Quantity</u>
Inert	9-13-52	100
Inert	9-19-52	50
Inert	9-21-52	65
HEAT	8-6-52	35
HEAT	8-13-52	50
HEAT	8-19-52	35
HEAT	9-13-52	35
HEAT	9-19-52	50

An additional 15 each of inert and HEAT T119E8 projectiles are being assembled and will be shipped to Picatinny Arsenal for loading during October. This ship-

ment will complete the entire quantity of T119E8 projectiles which were manufactured.

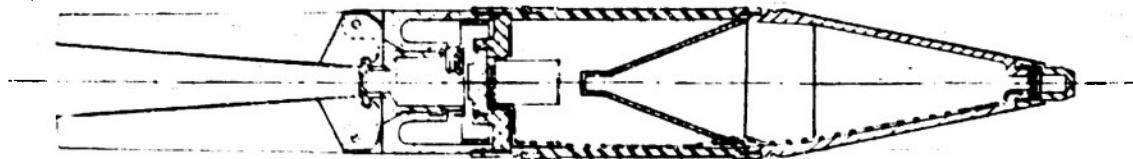
Future Program

A lot of 2500 T119E11 projectiles is being made. A chart showing details of the T119E11 projectile modification is given in Table XI. It is believed that

shipments of these projectiles will start in October, 1952 and that a rate of at least 100 per week can be reached shortly thereafter.

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Table VIII
T119E8 Modification



Part	Dwg. No.	Material	Weight (lb.)
NOSE	DRC-342	MALLEABLE IRON	3.49
BODY	DRC-341	SAE1045	5.58
HOUSING	DRC-412	24ST4	1.76
PISTON	DRB-198	SAE4140	.52
STOP	DRA-173	SAE4140	.09
FINS	DRD-334	24ST4 FORGING	1.01
PINS	DRA-730	SAE1020	.06
NOSE CAP	DRA-699	SAE1020	.21
PLUG	DRA-288	24ST4	.11
PLUG	DRB-419	24ST4	.58
OBTURATING BAND	DRB-420	COPPER	.20
CONE	DRB-398	COPPER	.90
O-RING	Ckcx3-1/8" x 3 7/8"	RUBBER	.01
GAS SEAL	PICATINNY ARSENAL DWG. 75-14-38		
BASE ELEMENT	PcMKE	COPPER & LEAD	.03
WIRE & TAPE	DRA-579	-----	.33
NOSE ELEMENT	DRA-628	NYLON & COPPER	--
PIN STRIP	DRA-496	BARIUM TITANATE	.02
GROMMET	DRA-454	BAKELITE	--
SHOCK PAD	DRA-492	NYLON	--
SHOCK PAD	DRA-493	FELT	--
SLEEVE	DRA-491	FELT	--
	DRA-498	TURBOSIL SILICONE GLASS	--
WASHER			
R. C. ASSY.	DRA-598	-----	--
INSULATOR	DRA-460	FELT	--
ASSEMBLY	DRD-262		
COMPOSITION B			2.79
PROJECTILE WEIGHT (CALCULATED)	17.82 LBS.		
C. P. .68 CAL. FROM HINGE PIN CENTER LINE, FINS OPEN			
C. G. 1.73 " " " "			
TOTAL LENGTH- FINS CLOSED 28.21 IN.			

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Table IX
Rang¹ Data, T119E8 Projectile
To Determine Accuracy at 2000 Yards

PROJECTILE

Model T119

Type EB

Weight (Nominal) 2.60 lb.

C.G. Location 210.1 a. from hinge pin &

Burrelet Diameter 4.130 in.

Special Features 4 slot in Obstruting Band

ABERDEEN PROVING GROUND, MD

TEST GUN

Model T117

Type EB

Length of Tube 10.5 in.

Twist of Rifling-Smooth Bore

Sighting Equipment T1B3 Sight Mount, M62E4 Elevation Telescope,

Gunner's Quadrant

Bore Dia. (Lands) .434 +.002 in.

Case T-53

Polymer T-81

Date 4-12-52 Program To determine Accuracy at 2000 yds

MISCELLANEOUS DATA

Range 2200 ft. Target 20 ft Square

Propellant PA-E-6084

Type M100 propell. 0.3 lbs Charge Wt. 8.16 lbs

Proof Director M. Cannon

APG, Arms & Ammunition

Observer C. M. Cox, J. Lucas, T. O'Boyle

Patron

Lot No. PA-E-10884

Round No	Proj. No.	Proj. Weight lbs	Powder Charge	Wind & Dir.	Chamber Pressure	Muzzle Velocity ^b	Azimuth ^c	Elev. ^d (mils)	Position of Hit ^e of Ht. - miles		Corrected Position ^f	Observations ^g
									Vert.	Horiz.		
1.	116	17.66	4-0		16.65	16.79	5°	+1 1/2	Missed	—	—	SHORT - APPEARED TO HIT RIGHT OF TARGET.
2.	110	17.65	7-0		16.74	16.88	5°	0	Missed	—	—	SHORT - RECOCKED THROUGH TARGET
3.	109	17.65	6-5		16.83	16.79	6°	0	Missed	—	—	SHORT - RECOCKED THROUGH TARGET
4.	126	17.61	6-10		16.86	17.00	6°	0	Missed	—	—	SHORT - RECOCKED THROUGH TARGET
5.	128	17.63	8-10		16.73	16.89	5°	0	Missed	—	—	STRIKE PLATE PROTECTING TARGET FOOTING - LEFT SIDE
6.	115	17.62	8-0		16.81	16.95	5°	1 3/4	18.65	+11.60	-3.11	1.93°
Firing Intervalluted 1000 ft. X 1000 ft. 2.4 hours												
7.	123	17.66	4-30		16.75	16.89	6°	1 3/4	Condonning	round	-RANGE END TEMP: 82°F	
8.	103	17.72	4-30		—	—	—	—	—	—	—	
9.	118	17.67	2-25		16.71	16.86	6°	1 3/4	—	—	—	
10.	107	17.65	2-30		16.82	16.96	6°	1 3/4	—	—	—	
11.	130	17.63	2-30		16.89	17.06	5°	1 3/4	—	—	—	
12.	117	17.61	3-40		16.75	16.91	5°	1 3/4	—	—	—	
13.	120	17.61	2-35		16.82	16.98	5°	1 3/4	—	—	—	
14.	121	17.59	1-40		16.85	16.99	5°	1 3/4	—	—	—	
15.	124	17.55	1-45		16.77	16.93	6°	1 3/4	—	—	—	
16.	106	17.51	1-50		16.81	16.95	5°	1 3/4	—	—	—	
17.	111	17.53	1-50		16.84	16.98	5°	1 3/4	—	—	—	
18.	119	17.52	0-50		16.76	16.90	5°	1 3/4	—	—	—	
19.	129	17.55	0-60		16.78	16.87	5°	1 3/4	—	—	—	
20.	113	17.51	0-55		16.72	16.93	5°	1 3/4	—	—	—	

CONTINUED ON NEXT PAGE

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Table IX (Cont.)

DATA 9-12-52 Program to determine accuracy at 2000 yds
ARMED PROVING GROUND, Md.

TEST GUN
Model IIA
Type EB
Weight (Nominal) 1760 lbs
C.G. Location 210 in. from hinge pin &
Bore Dia. (Lands) 2.620 in.
Special Features 1/64 in. Obstructing Band

Lot No PAF-10884

PROJECTILE
Model IIA
Type EB
Weight 1760 lbs
Wind a
Wind Velocity b
Wind Direction Val. & Dir.
Chamber Pressure
Instr. Actual (mils)

21. 102 17.52 1 -60 1669 1683 .59 135 -16.85 +15.16 -2.616 2.190
22. 112 17.55 2 -.55 1682 1696 .59 135 -17.65 +12.12 -2.983 2.026
23. 122 17.50 1 -60 1667 1681 .69 136 -17.85 +15.53 -2.983 2.261
24. 101 17.53 1 -.55 1676 1690 .69 136 -13.10 +17.93 -2.190 2.997
25. 108 17.60 0 -.50 1668 1682 .59 135 -15.65 +16.30 -2.616 2.724

a. Wind direction measured clockwise from south, angle of fire 26° west of south.
b. Used retardation factor of .190 ft/sec/sq sec.

c. Aiming point and position of hit reference is upper left hand corner of 20 ft. square target:
Elevation of target reference point 4.3 mils. Optical sight checked against bore sight before and after firing and was found to be unchanged.

d. Position of hit corrected to 59 mils elevation and +10 shot diameter.

e. Good flight characteristics observed for all rounds.

f. Projectiles were separated into two weight groups, the first thirteen being the heaviest. The heavy group of rounds originally totaled 15 but two rounds failed to chamber.

MISCELLANEOUS DATA

Range 5200 ft. Target 20 ft. square

Propellant TA-E-6084

Type 2000 lbs/in charge Wt. 816 lbs

Twist of Riffle 200 ft/in

Sighting Equipment TA-95 Sight Mount, M62E4 Elbow

Telescope, Gunner's Quadrant.

Bore Dia. (Lands) 2.620 in.

Case T-53

Primer T-81

Polyethylene-Rayon Liner.

Round No.	Proj. No.	Proj. Weight lbs	Powder Charge	Wind a	Chamber Pressure	Muzzle Velocity b	Elev. c	Azimuth d	Position of Hit e		Borehole Diameter	Clearance	Observations
									Vert.	Horiz.			
21.	102	17.52	1 -60	1669	1683	.59	135	-16.85	+15.16	-2.616	2.190		
22.	112	17.55	2 -.55	1682	1696	.59	135	-17.65	+12.12	-2.983	2.026		
23.	122	17.50	1 -60	1667	1681	.69	136	-17.85	+15.53	-2.983	2.261		
24.	101	17.53	1 -.55	1676	1690	.69	136	-13.10	+17.93	-2.190	2.997		
25.	108	17.60	0 -.50	1668	1682	.59	135	-15.65	+16.30	-2.616	2.724		

Center of Impact $\bar{Y} = 98$; $\bar{Z} = +1.92$ mils
 Probable Error-Vertical $\pm .50$ mil } FOR ROUND 6 THROUGH 25
 Probable Error-Horizontal $\pm .84$ mil } EXCLUDING ROUND NO. 7

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C O N F I D E N T I A L

Table X
Range Data, T119E8 and T119E4
To Determine Accuracy from Rifled Tube

PROJECTILE

Model T119
Type E8 & E4

Weight (Nominal) 1260 lb.
C.G. Location 21 in. from hinge pin S
Borelet Diameter 1.419 in.
Special Features Thread turned to +.010 in.

Date 9-18-52
E&W Ordnance Depot

TEST GUN

Model 206 arm. Recoilless
Type Blvd T19; 6000 cu.in. chamber liner; 20° branch
Length of Tube 106 in.

Twist of rifling 1-20

Sighting Equipment Model M16E1 bow telescope,
Gunner's Quadrant.

Bore Dls. (Lands) 0.648 in.²

Case - Reinforced to withstand loading plus
Primer - M67
Liner - T6, polyethylene cut off at base.

Program T119E2 to determine accuracy
of T119E8 from rifled tube.

MISCELLANEOUS DATA

Range 1029 yds. Target 12 ft. x 18 ft. wide.
Propellant PA 30240
Type M100B Pub. 0352 Charge W. 0161.02

Proof Director E. HUEYMAN

Observer LUCAS WEATHER CLARK

Round No.	Proj. No.	Powder Charge	Wind	Chamber Pressure	Muzzle Velocity	Elev. ^a	Azimuth ^b	Position of Hl (in.)	Corrected Position of Hl (in.-miles)	Observations
No. Type		Weight	Vel. & Dir.	Instr. (psi)	Inst. Actual	(mils)	(mils)	Vert.	Horiz.	
5/19/52	Zero elevation = +.6 mils									
1 E8 60	17.674									
2 E8 505	17.657			9000	1662 1678	22	0	-10.5	-1.498	c. Target 1029 yds. from the section of the last two shots caused a turning and tightening of the tube in the chamber of about one inch on the circumference. Target zero elevation was changed (3.6 mils after last round).
3 E8 262	17.61			9600	1696 1702	22	0	-23.5	-2.42	d. The breach was later shown to be so badly eroded that the recoil was forward and azimuths are with reference to target center.
4 E8 266	17.62			965	1678 1704	22	0	-57.0	-1.639	e. The breach was corrected to 22 mils elevation and a delay of 1.0 sec. was added after round No. 13.
5 E8 528	17.60			9200	1678 1714	22	0	-4.5	+1.121	f. Used retardation factor 1.00 ft/sec/ft
6 E8 320	17.62			9400	1682 1718	22	0	-15.5	-1.465	g. The breach was corrected to 22 mils elevation and a delay of 1.0 sec. was added after round No. 13.
7 E8 271	17.62			9480	1690 1726	22	0	-31.5	+1.445	h. The breach was corrected to 22 mils elevation and a delay of 1.0 sec. was added after round No. 13.
8 E8 277	17.65			9500	1683 1729	22	0	+13.5	-0.670	i. The breach was corrected to 22 mils elevation and a delay of 1.0 sec. was added after round No. 13.
9 E8 324	17.61			9800	1682 1718	22	0	-14.0	+1.00	j. The breach was corrected to 22 mils elevation and a delay of 1.0 sec. was added after round No. 13.
10 E8 307	17.65			9600	1681 1717	22	0	+28.0	+1.756	k. The breach was corrected to 22 mils elevation and a delay of 1.0 sec. was added after round No. 13.
11 E8 294	17.60			9400	1690 1726	22	0	-7.5	0.0	l. The breach was corrected to 22 mils elevation and a delay of 1.0 sec. was added after round No. 13.
12 E8 267	17.62			9500	1691 1727	22	0	+10.0	-1.810	m. The breach was corrected to 22 mils elevation and a delay of 1.0 sec. was added after round No. 13.
13 E8 323	17.65			9400	1696 1682	22	0	struck 2nd velocity screen.		
5/19/52	Fired with +2.35 -002 in. rotating band.									
5/19/52	Fired with +23.5 -002 in. rotating band.									
14 E8 274	17.66			10 - 165	8900 1652	23.1	0	+67.6	-50.6	-1.363
15 E8 253	17.67			10 - 170	9300 1676	23.1	0	Just over target	+1.597	Screen distances: Parallel to 18°
16 E8 272	17.64			10 - 170	9300 1676	22.1	0	+61.0	-42.0	Screen 11 ft.; 1st to 2nd 72.5 ft.
17 E8 278	17.61			10 - 165	9100 1676	21.1	0	-34.0	+1.256	
18 E8 293	17.62			8 - 170	9200 1676	21.1	0	-13.5	+0.45	
19 E8 321	17.61			15 - 175	9300 1675	17.1	0	-45.5	-0.550	
20 E8 256	17.61			11 - 170	9100 1677	17.3	2.1	-28.0	-1.610	
21 E8 326	17.66			12 - 185	8900 1650	16.86	2.1	0	-61.5	+2.85 -1.747

Center of Impact Rounds 2-3 C.I. = -.28, C.I. = -.06 mils; Rounds 4-21 C.I. = .29, C.I. = -.69 mils.
 Probable Error-Vertical = .44 mil.
 Probable Error-Horizontal = .47 mil.

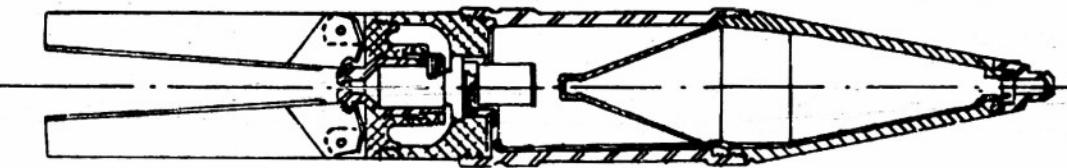
For all hits except #11 which was on E-type projectile

Centers of impact for morning & afternoon groups were superimposed.

Stripped - 1. P. 35000 ft.

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Table XI
T119E11 Modification



Part	Dwg. No.	Material	Weight (lb.)
NOSE	DRC342	MALLEABLE IRON	3.49
BODY	DRC497	SAE1045	5.64
HOUSING	DRB573	24ST4	.95
CHAMBER	DRC442	24ST4	1.82
PISTON	DRB198	SAE1137	.54
STOP	DRA173	SAE1137	.09
FINS-CANTED	DRD334	14ST6 FORGING	1.02
PINS	.875X.2500	SAE1020	.07
NOSE CAP	DRA699	SAE1112	.21
PLUG	DRA670	24ST4	.11
CONE	DRB398	COPPER	.86
O-RING	DRA459	RUBBER	--
GAS SEAL	PICATINNY ARSENAL DWG. NO. 75-14-38		
BASE ELEMENT	PcMKE	COPPER & LEAD	.02
WIRE & TAPE	DRA579	-----	.33
NOSE ELEMENT	DRA628	NYLON & COPPER	--
PIN STRIP	DRA496	BARIUM TITANATE	.03
GROMMET	DRA454	BAKELITE	--
SHOCK PAD	DRA492	NYLON	--
SHOCK PAD	DRA493	FELT	--
SLEEVE	DRA491	FELT	--
	DRA498	TURBOSIL SILICONE GLASS	--
WASHER			
R.C. ASSY	DRA598	-----	--
INSULATOR	DRA460	FELT	--
ASSEMBLY	DRD391	-----	--
COMPOSITION B			2.79
PROJECTILE WEIGHT (CALCULATED)			17.97
C.G. 1.68 CAL. FROM HINGE PIN CENTER LINE, FINS OPEN			
C.P. .68 CAL. FROM HINGE PIN CENTER LINE, FINS OPEN			
TOTAL LENGTH - FINS CLOSED 28.08 IN.			
NOTE: All components of T119E11 are identical with those of T119E10 with the exception of the body. The obturating band groove has been eliminated from the new body to permit firing of the T119E11 projectile from rifled tubes.			

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PENETRATION STUDIES

Effect of Internal Tee Configuration

The reduction in penetration resulting from the use of a DRC314 tee with a non-rotated DRB398 cone was described in the Twenty-Fourth Progress Report. Tests reported in the Twenty-Fifth Progress Report showed that the major portion of the interference is in the boom and/or boom entry hole. These tests have been continued.

Four series of rounds with various tees, totaling twelve rounds, have been tested. Figure 9 shows the various tee modifications. Cone inspection data are shown in Table XII and penetration data are given in Table XIII.

The average penetration for the three

rounds with unmodified tees is 16.83 inches, 4.0 inches less than the penetration of the controls without tees. The average penetration for the rounds having modifications C and D are 17.75 and 17.89 inches, respectively, indicating that about one inch of penetration may be gained by enlarging the boom entry hole slightly. Modification E, complete removal of the boom, permitted an average penetration of 19.00 inches, 2.2 inches better than the unmodified tee but 1.8 inches poorer than a standard nose ring. Thus, of the four inch reduction in penetration arising as a result of jet interference in the DRC 314 tee, approximately 50% (2 inches) is lost in the boom, and 50% (2 inches) is lost in the entry hole to the boom. About 25% (1 inch) may be recovered by enlarging the boom entry hole slightly.

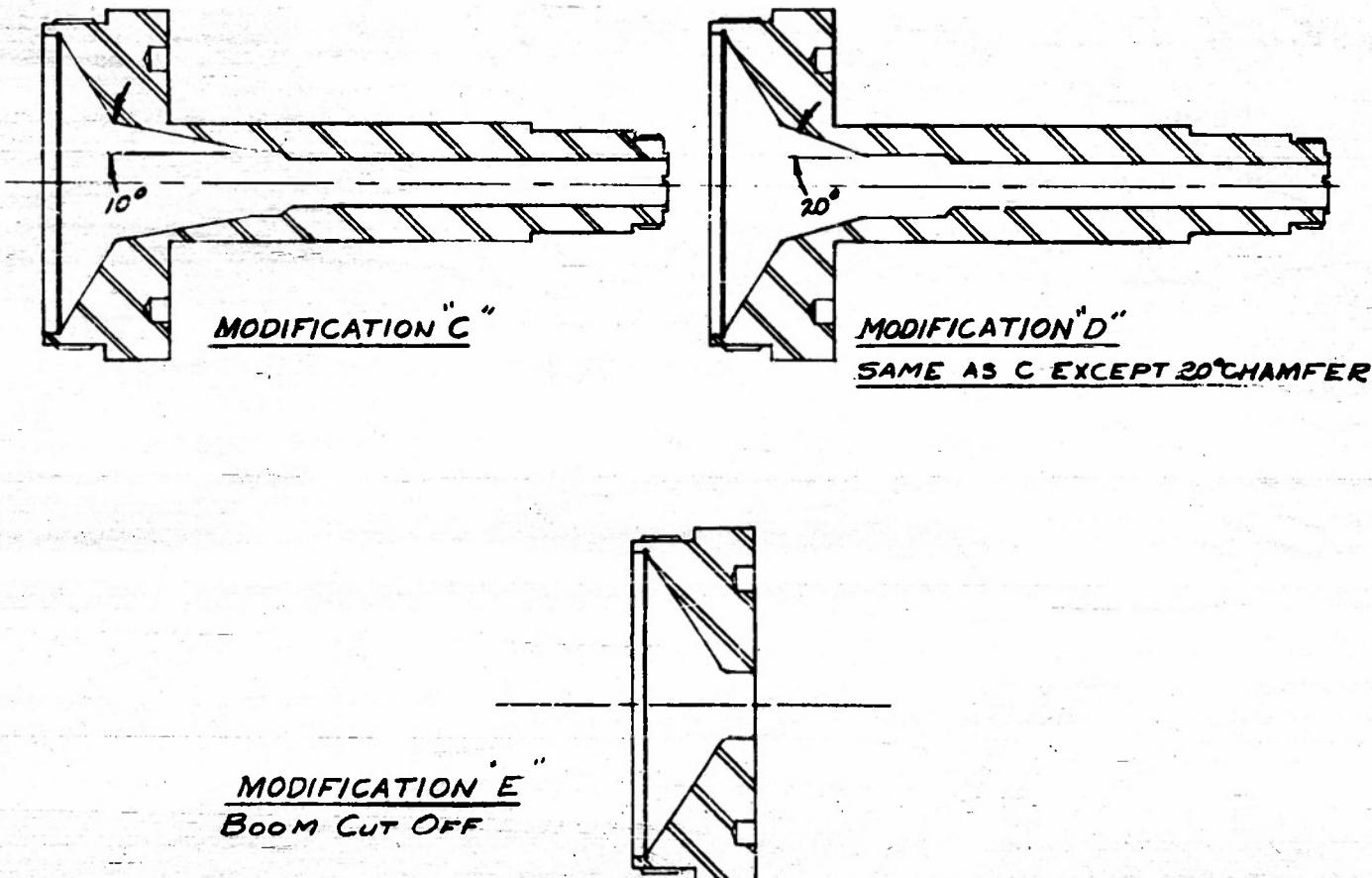


Fig. 9. Various Tee Modifications.

C O N F I D E N T I A L

Table XII
Inspection Data

Cane No.	Maximum Variation		Wall Thickness		Concentricity T.I.R.	
	Transverse	Longitudinal	Maximum	Minimum	Charge to Bourrelet	Cone to Bourrelet
Q373	.006	.005	.104	.098	.003	.007
Q374	.005	.005	.103	.097	.002	.008
Q442	.003	.005	.103	.098	.001	.011
Q443	.002	.005	.103	.099	.001	.011
Q635	.002	.003	.101	.098	.002	.008
Q639	.001	.002	.106	.104	.001	.004
Q645	.002	.001	.105	.103	.001	.003
Q649	.004	.002	.105	.101	.002	.003
Q650	.003	.003	.103	.100	.002	.008
Q655	.006	.005	.105	.099	.002	.007
Q660	.003	.003	.103	.100	.002	.006
Q665	.003	.003	.101	.098	.001	.003

Notes:

1. All measurements are in inches.
2. All cones are drawn DRB398 cones.

Table XIII
Penetration Data
For Modified DRC 314 Tees

Round No.	Tee	Lbs.Comp B	Penetration (inches M.S.)	Max.Spread (in.)	Std. Dev. (in.)
Q443	DRC314	2.58	16.25		
Q660	"	2.58	16.50		
Q665	"	2.58	17.75		
		Avg. 2.58	16.83	1.50	±.81
Q373	Mod. C.	2.58	19.38		
Q635	"	2.60	16.18		
Q639	"	2.60	17.69		
		Avg. 2.60	17.75	3.20	±1.57
Q442	Mod. D	2.60	19.31		
Q650	"	2.60	17.75		
Q655	"	2.60	16.62		
		Avg. 2.60	17.89	2.69	±1.35
Q374	Mod. E	2.60	19.69		
Q645	"	2.62	18.88		
Q649	"	2.60	18.44		
		Avg. 2.61	19.00	1.25	±.63
Controls (DRC376 Assemblies)			Avg. 20.80	1.00	±.48
See page 26 of Twenty-Fifth Progress Report.					

Notes:

1. DRC376 bodies and base plugs, tees as indicated.
2. Loaded at Ravenna Arsenal, BAT Lot #17, Comp B from Holston Lot 3-126.
3. All rounds fired at 0 rev/sec and 7.5 inches standoff.

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Future Program

1. Conduct penetration versus standoff tests for 45° and 20° copper cones (100-inch wall) with head of H.E. held constant at 3.63 in.

2. Evaluate the influence of DRC 314 tees made of (a) mild steel (b) high ductility malleable iron, and (c) low ductility malleable iron.

3. Continue tests to determine the effect of interior tee configuration upon

penetration.

4. Continue scaling studies with smaller liners.

5. Composite cones. The penetration behavior of steel and of aluminum cones each with thin copper inserts, and of copper cones with thin aluminum inserts, is being compared with homogeneous copper cones. Initial tests will be at 0 and 25 rev/sec.

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FUZES

T223E2 Superquick-Delay Mechanical Fuze

Nine rounds containing T223E2 fuzes (Fig. 11, Twenty-Fifth Report) were fired at Erie Ordnance Depot. Six, loaded with spotting charges, were fired against a 3 1/2-in. wooden bursting screen. Three, set for superquick functioning, were observed to function on the screen. Two of three others, set for delay functioning, were observed to function after passing through the 3 1/2-in. wooden bursting screen.

The three remaining rounds were fired into the recovery box to study the functioning of the delay element. All three were recovered and inspection showed that the delay elements in each had functioned properly.

T222E3 (DRA 496-2) Nose Element Crystal Assemblies

Test slugs weighing fifteen pounds have been fired from a 75mm gun at T138 E57 tee assemblies containing T223E3 crystal assemblies. In each case a BS28 indicator and an oscilloscope were connected in parallel across the crystal.

Attempts to photograph the voltage-time trace were continued but in these tests the film was presensitized according to the directions in the Dumont 297 Camera Manual. A one megohm potentiometer was placed across the vertical plates of the oscilloscope to obtain a greater attenuation than is available using the internal control.

Four projectiles were fired in this test but only two hit the tees squarely enough to close the foil switch (of the two rounds that failed to close the switch,

one hit the rim of the tee cap and the other hit the shoulder of the tee). The BS28 indicator functioned on all four rounds. The voltage-time trace for round four was successfully photographed and showed that a peak of 800 volts was produced.

A subsequent firing of seven projectiles produced two additional hits. Readable pictures were obtained for both of these rounds. The maximum voltage for one round was 900 volts. This voltage fell to 100 volts in .56 microseconds.

The maximum voltage for the second round was 650 volts, which fell to 150 volts in 1.5 microseconds. The voltage rise time was too short for accurate determination. Additional tests are planned.

Base Elements (DRD328) for T222E5 Fuze

Six T138E57 projectiles containing DRD328 base elements (Fig. 10 of Twenty-Fifth Progress Report) and T222E3 nose elements (DRA496-2) were fired. Each round contained a tetryl pellet and sufficient spotting charge to make possible an observation of functioning. Five rounds were fired at 4-in. wooden bursting screens; two at 75 ft (the maximum arming distance permissible under contract DA-33-019-ORD33); two at 100 ft and one at 200 ft. None of the fuzes functioned. Therefore, the remaining round was fired for recovery. Subsequent examination of the recovered round disclosed that it was unarmed. The setback pins had failed to release the rotor. The inner surface of the holes for the setback pins was quite rough. Furthermore, the number two pin was found to have a too small bearing surface at one end, permitting the pin to tilt and bind. Further tests are planned.

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Future Program

1. Fire a confirmatory test group of 10 T223E2 fuzes, set for delay, before incorporating such fuzes in live loaded HE rounds.
2. Continue the experiments to determine the power generated by the "lucky" elements.
3. Repeat the arming distance experiments on T222E5 base elements using longer arming pins and with an improved finish on the holes.

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